#2130 THE INSTITUTE OF PAPER CHEMISTRY
(Ultracentrifuge Instrument)
Project Reports

THE INSTITUTE OF PAPER CHEMISTRY

QUARTERLY RESEARCH REPORT

DIVISION: Natural Materials & Systems

DATE: October 1, 1974

PROJECT NO.: 2130, Ultracentrifugal Sedimentation Studies

Project Leader: John Carlson

Class: FE

OBJECTIVE: This project was started in March, 1959, according to the research order "to maintain satisfactory operational logs for the ultracentrifuge instrument." Over the years this objective has been expanded to include all work performed on or for the Model E Ultracentrifuge classified as maintenance, alignment, modification, development of auxiliary equipment and computer programming.

BUDGET: None specified. Estimated for 1974-75:

Staff time - 5 hours per week
Materials (including Beckman service agreement - $1200
Computer time - minimum ($5 per month)

SCHEDULE: The Model E is used fairly extensively and requires maintenance frequently. Complete optical alignment is done normally only after a drive change, about once in two years. Other charges to 2130 are sporadic and dependent on instrument performance.

SUMMARY OF RESULTS AND PLANS FOR FUTURE WORK:

As a result of our maintenance plus that done by Beckman, the instrument has been kept in good working condition.

Approximately ten years ago, an adjustable light limiting mask for the Rayleigh interference optical system was designed and installed. Because this mask can be adjusted rotationally and laterally while a rotor is spinning, a precise alignment is possible.

In 1967 an automatic data recording system was designed and assembled. This system has made possible rapid and accurate processing of ultracentrifuge data as well as other applications.

Computer programs have been written for most ultracentrifuge methods including the determination of molecular weights, diffusion constants, sedimentation coefficients, etc.

Report Prepared by John Carlson

PROJECT REPORT FORM

PROJECT NO. 2130
COOPERATOR
REPORT NO. 1
DATE March 21, 1967
NOTE BOOK
PAGE
SIGNED K. W. Hardacker

K. W. Hardacker

Dr. Dillingham
Mr. Swanson
Mr. Hardacker (2)
Dr. Van den Akker
Dr. Van Horn
Files

DIGITAL READOUT X-Y COORDINATE COMPARATOR

INTRODUCTION

The ultracentrifuge and the electrophoresis apparatus have outputs in the form of images on photographic plates. The coordinates of many points on each plate must then be measured in order to obtain the raw data of each test run. For several years, this has been done on a Microfilm-type projector which had been modified to form a comparator by replacing the film holder with a plate-holding carriage translatable in the x and y directions by means of micrometer screws. The great amounts of time required and the difficulty and error proneness in reading and recording the micrometer screw settings and later punching these settings on IBM cards have seriously limited the use of the ultracentrifuge and the electrophoresis apparatus.

Based on Dr. Dillingham's August 5, 1965 memo to Mr. Swanson, a system has been assembled to automatically punch the x-y table coordinates on IBM cards. The choice of system was dictated by Dr. Dillingham's specifications for performance, by the need for using the original comparator, and by the availability and cost of the additional components needed. In final form, this system differs somewhat from that outlined in the memo.

SYSTEM DESCRIPTION

A block diagram of the system is shown in Figure 1, while Figure 2 is a photograph showing the actual physical appearance of the system. Briefly, handwheels turn screws which position the x-y table of the comparator and also turn x and y digital shaft encoders. The outputs of these encoders are continuously displayed by the display unit (one least count = 1/12,000 inch). When coordinates are to be recorded, depressing a foot switch causes the displayed reading to be transferred to the translator and thence to a punched card.

The translator stores the transferred display reading during card punching; therefore, the operator need not wait for completion of card punching before turning the handwheels to a new set of coordinates. The time now required for reading an ultracentrifuge plate and punching this information on IBM cards is about 40 minutes; this compares with a time of about 140 minutes with the prior equipment. Improved computer programs can cut this time even more.

The system can also be used, of course, for making any one or two-axis measurements of any object which will fit on the x-y table, including, especially, photographic plates from other instruments. Examples of such other uses are data reduction from x-ray diffraction plates and measurement of strain in paper based on reduction of photographic data. Over fifty percent saving of time has already been realized for these operations, with even greater saving of time anticipated with improved computer programs.

The various components and their functions are described in somewhat more detail in the following sections. Complete manufacturers' literature and instructions for the operation and maintenance of the purchased components are bound in the instruction manual kept with the instrument.

POWER PANEL

Power (120 V, 60 Hz) for equipment in the rack enters the power panel, passes through a main switch, and is distributed to the other units. This panel also supports (a) a Variac for controlling the intensity of the comparator illumination, (b) the d-c power supply and the two drive circuits for the encoders, and (c) an electromagnetic counter for recording the total number of coordinate pair readings punched by the card punch in each series of readings.

COMPARATOR

Comparator illumination is provided by a no. 1503 lamp in the comparator housing. Access to the lamp may be had through openings in the shelf on which the comparator sets and in the bottom of the comparator housing. A Jena BG-10 infrared-stopping filter has been cemented over the light opening below the x-y table.

To facilitate focusing the image of the plate to be read on the screen of the comparator, a focusing screw has been added to the projector lens. The adjusting knob of this screw projects from the front of the housing of the objective lens, where it is easily accessible.

The original micrometer screws have been removed from the x-y table and replaced by special screw systems designed for use with the digital encoders. That screw system for the y direction is shown in Figure 3. Travel has been extended to the limits permitted by the table: four inches in the x direction and a little under two inches in the y direction. The translating screws have 40 threads/inch, there is a 3:1 step-up gear ratio from the screws to the encoders, and the encoders produce 100 counts/revolution; thus, each count represents 1/12,000 inch. The screws turn in bearing bronze nuts and should be kept lightly lubricated with clock oil. Mechanical drawings of the screws and screw frame assemblies are filed

in the Plant Engineering office.

ENCODERS

The encoders are Norden type 5BBCD 4C PV absolute position, brush type, binary decimal shaft encoders. They are driven by the stage translating screws as shown in Figure 3. Each encoder produces 100 counts/revolution and has a capacity of 1000 revolutions. (Only part of the capacity of each encoder is used with the comparator.) A Sorensen QMA 21-0.24 d-c power supply and two Norden 02011-004-1 drive circuits for the encoders are mounted on the power panel.

BUFFER

The Dymec DY-8415 buffer unit changes the output voltage and impedance levels of the encoders to levels compatible with the input voltage and impedance requirements of the display unit.

DISPLAY UNIT

The Hewlett-Packard KO2-5211B dual remote readout unit continuously displays the readouts from the digital shaft encoders: one 5-digit decimal number for the x axis and a second 5-digit decimal number for the y axis. It is thus possible to position the x-y table to predetermined locations without needing to punch cards to check the location. The readout of the comparator may, of course, be made directly from the display unit if punched cards are not needed.

TRANSLATOR

The Dymec DY-2526 card punch set, on command from the foot switch, (a) transfers, in 2 ms time, the x and y data from the display unit to its own memory, (b) converts the data to a form suitable for operation of the card punch, and (c) feeds this information in serial form to the card punch in response to commands

from the card punch. The storage feature speeds comparator operation by allowing the table position to be changed immediately after operating the foot switch.

COUNTER

A 4-digit, electromechanical counter, with push button reset, is mounted in the power panel and connected to register one event each time the foot switch is operated. A count of the number of coordinate data points punched on the IBM cards is thus automatically accumulated and may be used in whatever manner the computer program requires in subsequent handling of the data.

CARD PUNCH

An IBM 526 card punch is the final output device of the comparator system. By appropriate wiring of the control panel and punching of the master program card, any or all of the ten digits stored in the translator may be punched in any format or order on the IBM cards. The automatic punching rate is 15 characters/second.

The manual keyboard of the punch may also be used at any time except during the automatic punching cycle. And, of course, the punch may also be used alone for other purposes.

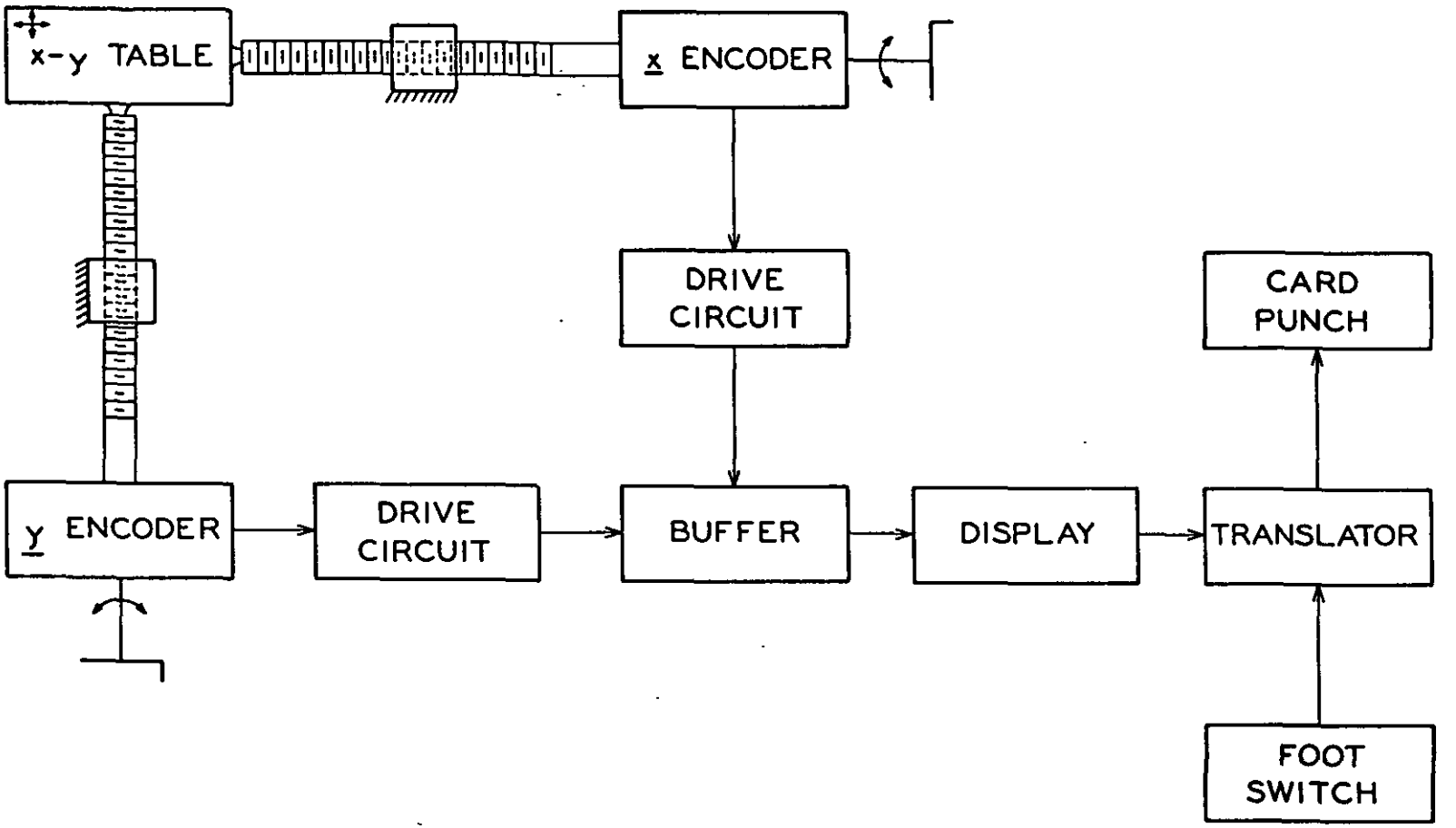

Figure 1. Elementary block diagram of the Digital Readout X-Y Coordinate Comparator

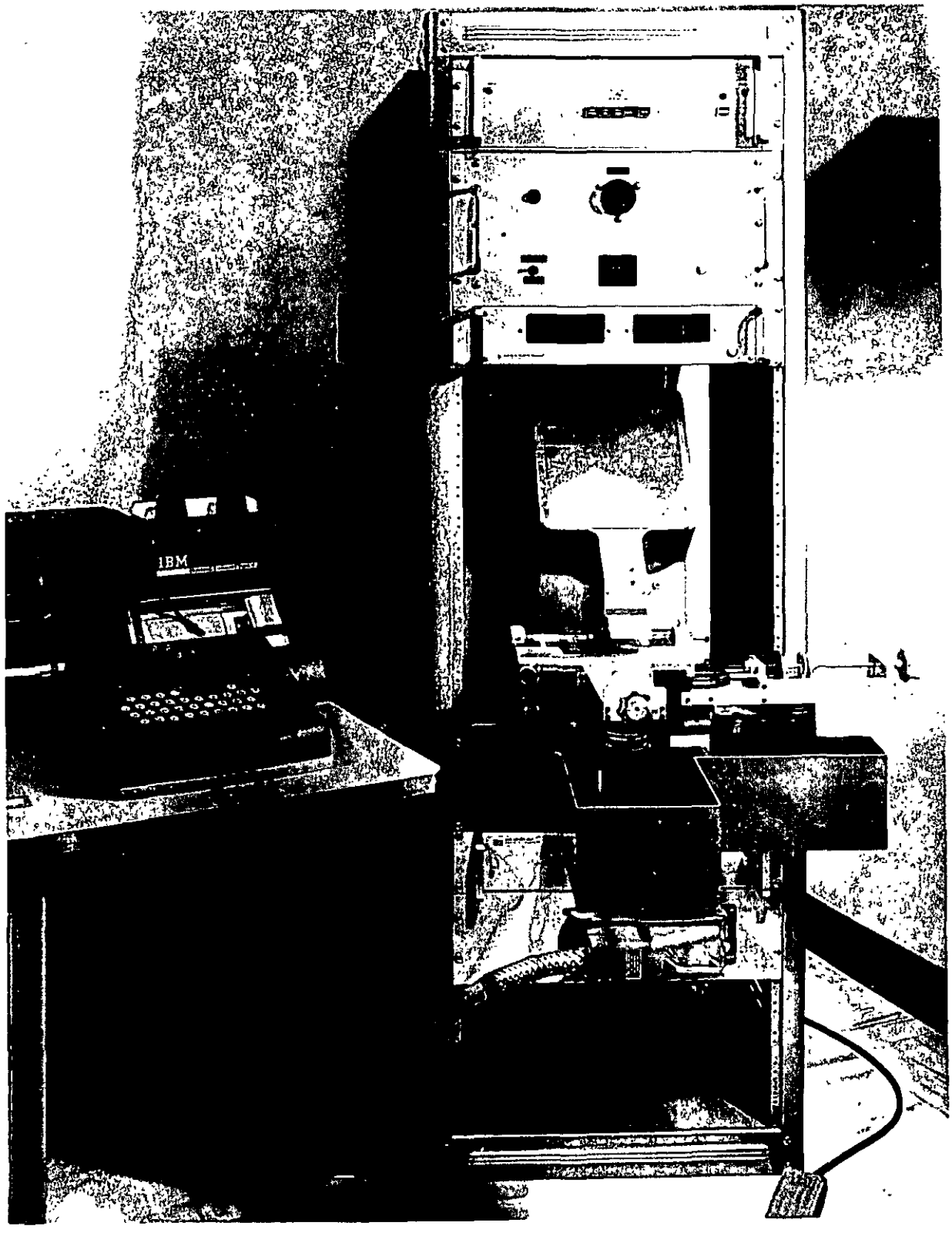

Figure 2. Photograph of the Digital Readout X-Y Coordinate Comparator

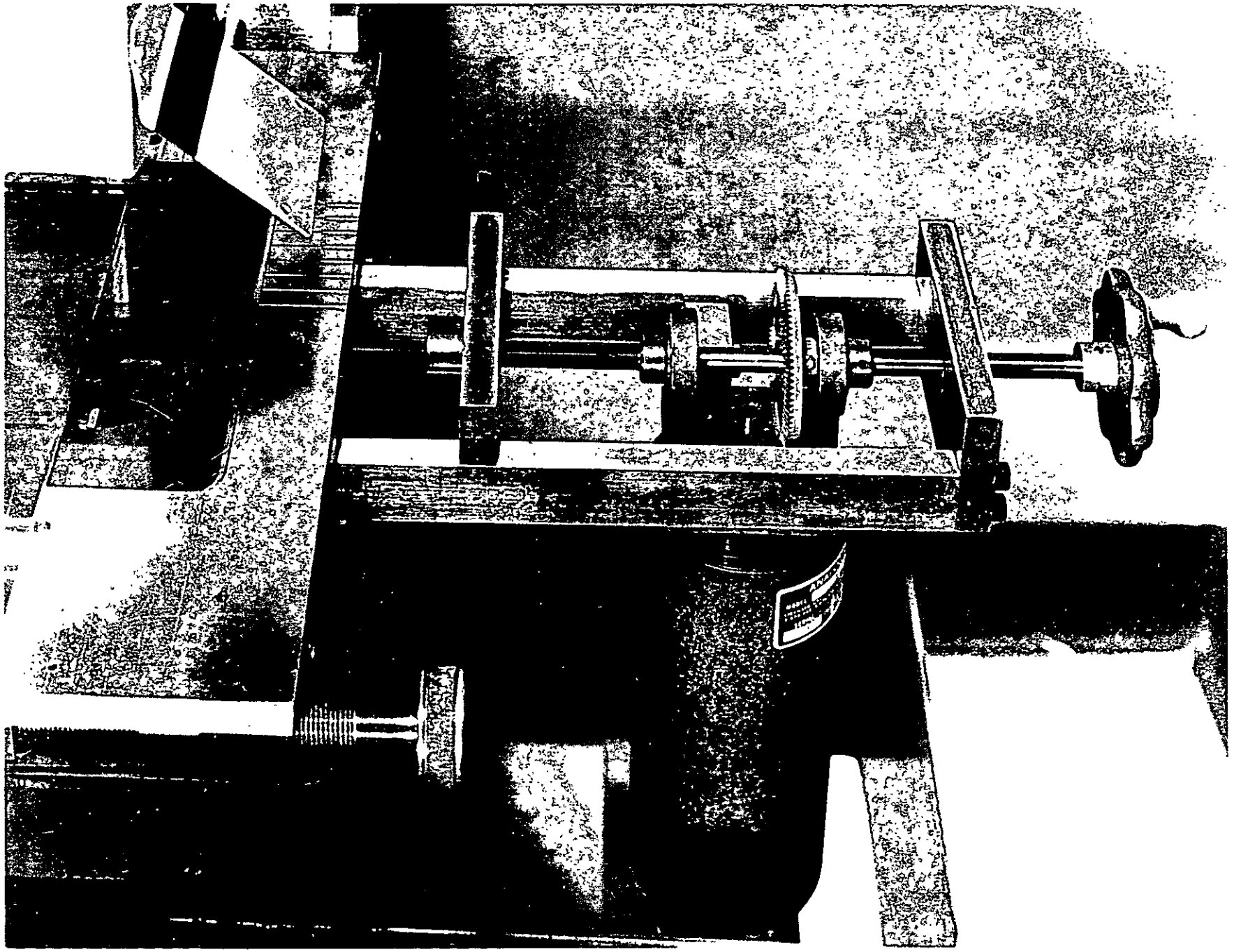

Figure 3. Photograph of the y-axis table-translating screw and its digital shaft encoder